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Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention concerns a suspension system for a motor vehicle wheel comprising front and rear lateral link means pivoted to a vehicle frame at their inner ends and pivoted to a wheel support at their outer ends; front and rear resilient members connected to said front and rear lateral link means arranged to influence the toe characteristics of the wheel, the structure and/or elastic properties of said resilient members and their arrangement with respect to said link means being such that the extent of deflection of the wheel in the toe-in-direction in response to a transversely inwardly directed side force applied to the wheel changes as the side force acting on said wheel is increased.

Description of the Prior Art

Recent developments in motor vehicles include an improvement in the suspension system so that the toe direction of a wheel, particularly a rear wheel is controlled in accordance with a running condition of the vehicle to thereby provide the vehicle with a desirable running property. For example, the U.S. patent 4,621,830 discloses a vehicle suspension system in which the toe direction of a rear wheel is changed under a sidewardly directed force acting from the road to the wheel in a manner that the rate of change in the toe direction is increased as the side force is increased beyond a certain value. For example, the toe direction of the wheel is changed with a first ratio with respect to a change in the side force under the certain value of the side force, but the ratio is increased when the side force is increased beyond the certain value. With this structure, it becomes possible for example, as shown by the line b in Figure 14 of said U.S.-patent 4,621,830, to produce a toe-in movement in the rear wheel under a fast cornering operation or a lane change operation of the vehicle wherein the rear wheel is subjected to an increased side force to ensure a stable road gripping while suppressing a toe-in movement under an operation wherein the side force is small to permit a turning of a relatively small radius.

As an alternative solution, proposals are made to provide the vehicle suspension system with a hydraulic actuator for controlling the toe direction of the wheel. A detector is provided for detecting the side force in terms of a sideward acceleration so that the hydraulic actuator is operated when the side force is increased beyond a predetermined value to produce a toe-in movement of the wheel.

The conventional arrangements described above are designed so that the rear wheels are shifted in the toe-in direction as the side force is increased to thereby obtain an improved steering stability. It is also expected that the stability in a straight road operation can also be improved by this toe control. This is based on the concept that the vehicle running stability can be improved by shifting the rear wheels in a toe-in direction to thereby provide an improved road gripping of the wheels.

It should however be noted that the toe control of the rear wheels under the side force is not satisfactory in obtaining an improved stability in a straight road operation. This is particularly true under a high speed vehicle operation.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a vehicle suspension system in which system the toe direction of a wheel is controlled under a side force acting on the wheel but the stability under a high speed straight vehicle operation can be ensured without sacrificing the small turning radius under a small side force and a steering stability under a large side force, in which system further the toe direction of a wheel can be changed in three different ways in accordance with the side force acting on the wheel, and the wheel is shifted to conduct a toe-in movement in a greater extent under an operation on a straight path and an operation which will produce a large side force, than under an operation in a curved path under a slow speed.

The present invention is based on the recognition by the inventors that the side force which acts on the wheels is much smaller in an operation on a straight path than in an operation for a fast turning or a lane change wherein a large side force is produced. In fact, the side force under an operation in a straight path is smaller than that under a slow speed turning wherein the side force is relatively small.

According to the present invention, there is therefore provided A suspension system for a motor vehicle wheel comprising front and rear lateral link means pivoted to a vehicle frame at their inner ends and pivoted to a wheel support at their outer ends; front and rear resilient members connected to said front and rear lateral link means arranged to influence the toe characteristics of the wheel, the structure and/or elastic properties of said resilient members and their arrangement with respect to said link means being such that the extent of deflection of the wheel in the toe-in-direction in response to a transversely inwardly directed side force applied to the wheel changes as the side force acting on said wheel is increased, **characterised** in that the extent of toe-in wheel deflection increases as the side force is increased until a predetermined magnitude of side force is reached, after which the extent of toe-in deflection decreases with increasing side force until a second predetermined magnitude of side force is reached, after which the extent of toe-in wheel deflection again increases with increasing side force.

Improvements of this inventive solution are defined in the subclaims and described in the following description of the drawings.

The above and other objects and features of the present invention will become apparent from the following descriptions of preferred embodiments taking reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a fragmentary plan view of a vehicle rear suspension system embodying the features of the present invention;

Figure 2 is a diagram showing several types of wheel toe direction changes;

Figure 3 is a plan view of the rear wheel in the suspension system in Figure 1 showing the movements of the wheel under the side force;

Figure 4 is a diagram showing the relationship between the side force and the deflection of the rubber bushes in front and rear links;

Figure 5 is a perspective view of one of the front and rear links in the suspension system in Figure 1;

Figure 6 is a cross-sectional view of the rubber bush used in the connection between the link and the wheel support;

Figure 7 is an axial sectional view of the rubber bush shown in Figure 6;

Figure 8 is a cross-sectional view of the rubber bush used in the connection between the front link and the vehicle body;

Figure 9 is an axial sectional view of the rubber bush taken along a line IX-IX in Figure 8;

Figure 10 is a cross-sectional view of the rubber bush used in the connection between the rear link and the vehicle body;

Figure 11 is a sectional view taken along the line XI-XI in Figure 10;

Figure 12 is a plan view of a vehicle rear suspension mechanism showing another example to which the present invention can be applied;

Figure 13 is a perspective view showing a further example of the vehicle rear suspension mechanism to which the present invention can be applied;

Figure 14 is a perspective view of a further different type of the vehicle rear suspension mechanism to which the present invention can be applied;

Figure 15 is a horizontal sectional view showing a connection between the lateral links and the vehicle body in another embodiment of the present invention;

Figure 16 is a horizontal sectional view similar to Figure 15 but showing a further embodiment of the present invention;

Figure 17 is a diagram similar to Figure 4 but showing deflections of the rubber bushes in a further embodiment of the present invention;

Figure 18 is a perspective view similar to Figure 5 but showing the link having the rubber bush which shows the deflection characteristics as shown in Figure 17;

Figure 19 is a plan view similar to Figure 1 but showing a further different embodiment of the present invention;

Figure 20 is a sectional view showing the structure of the resilient mechanism in the link used in the suspension system of Figure 19;

Figure 21 is a cross-sectional view of the rubber bush used in a further embodiment of the present invention;

Figure 22 is a diagram similar to Figures 1 and 17 but showing another example of the deflections in the rubber bushes;

Figure 23 is a cross-sectional view of a rubber bush which shows the deflection shown in Figure 22;

Figure 24 is a cross-sectional view of a rubber bush showing another example which provides the deflection as shown in Figure 22;

Figure 25 is a plan view similar to Figures 1 and 19 but showing a further embodiment of the present invention;

Figure 26 is a sectional view showing the resilient mechanism used in the link of the suspension mechanism; and,

Figure 27 is a sectional view similar to Figure 26 but showing another example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, particularly to Figure 1, there is shown a vehicle rear suspension system to which the present invention is applied. The left and right suspension mechanisms are symmetrical with each other so that corresponding parts are designated by the same reference numerals with a suffix L for the left hand mechanism and a suffix R for the right hand mechanism. Further, descriptions will be made only for the right mechanism and the descriptions for the left mechanism will be omitted unless it is necessary.

Referring to Figure 1, the vehicle has a body B provided with a rear sub-frame 1 which is connected through a suspension mechanism 2R with a rear wheel 3R. The suspension mechanism 2R comprises a front lateral link 4R and a rear lateral link 5R which extend in a lateral direction of the vehicle body B. The wheel 3R is supported for rotation about a rotation axis by a wheel support or a wheel hub 6R which has a spindle 15R for rotatably supporting the wheel 3R.

Thefront lateral link 4R is connected at the laterally inner end with a pin 7R on the sub-frame 1 through arubber bush 8R. The laterally outer end of the front lateral link 4R is connected with a pin 11R on the wheel support 6R through a rubber bush 12R. Similarly, the rear lateral link 5R is connected at a laterally inner end with a pin 9R on the sub-frame 1 through a rubber bush 10R. The laterally outer end of the link 5R is connected with a pin 13R on the wheel hub 6R through a rubber bush 14R. In the embodiment shown in Figure 1, the front and rear lateral links 4R and 5R are substantially parallel with each other and the spindle 15R for supporting the wheel 3R is located between the outer ends of the links 4R and 5R. It will be noted in Figure 1 that the pins 7R, 9R, 11R and 13R and the rubber bushes 8R, 10R, 12R and 14R have their axes arranged substantially in the longitudinal direction of the vehicle body B. Therefore, the rear wheel3R is vertically swingable with respect to the vehicle body B.

A tension rod 17R is provided to extend substantially in the longitudinal direction of the vehicle body B. The tension rod 17R has a rear end which is connected with a pin on the wheel hub 6R through a rubber bush 18R. The front end of the tension rod 17R is connected with a pin 20R on the vehicle body B through a rubber bush 19R. The pins 16R and 20R and the rubber bushes 18R and 19R have axes extending substantially in the transverse or lateral direction with respect to the vehicle body B so that they do not disturb the vertical swinging movement of the wheel 3R. As well known in the art, a strut assembly 27R is provided between the vehicle body and the wheel hub 6R.

In the embodiment being described, the rubber bush 8R has a deflecting property which is different from that of the rubber bush 10R. Figure 4 shows the deflections of the rubber bushes 8R and 10R under a side force acting on the wheel 3R. The rubber bush 8R shows a deflection at a relatively greater rate until the side force increases to a value S-1 and then the rate of deflection decreases in the range of the side force beyond the value S-1. The rubber bush 10R shows a deflection rate which is smaller than the deflection rate of the rubber bush 8R under the side force below S-1 but larger than the deflection rate of the rubber bush 8R under the side force greater than the value S-1 until the side force increases to a second value S-2 which is larger than the value S-1. As the side force increases beyond the value S-2, the deflection rate increases to a value greater than that of the rubber bush 8R under the side force beyond the value S-1.

As shown in Figure 4, the deflection curve for the rubber bush 8R intersects the deflection curve for the rubber bush 10R at two points r1 and r2. It will therefore be understood that with the side force lower than the value corresponding to the point r1, the front bush 8R shows a greater deflection than the rear bush 10R does. Between the values of the side force corresponding to the points r1 and r2, the deflection of the front bush 8R is smaller than that of the rear bush 10R. Further, with the side force greater than the value corresponding to the point r2, the deflection of the front bush 8r again becomes greater than that of the rear bush 10R. The outer bushes 12R and 14R have the same deflecting property.

With the aforementioned arrangement, it is possible to have the rear wheel toe direction changed as shown in Figure 2. Under the side force smaller than the value corresponding to the point r1, the rear wheel 3R is moved in the toe-in direction as shown by the solid line with the peak value of the toe-in movement produced under the value S-1 of the side force. Under the side force between the values corresponding to the points r1 and r2, the rear wheel is moved in toe-in direction with the peak value appearing under the side force S-2. Under the side force greater than the value corresponding to the point r2, the wheel is moved again in the toe-in direction. By appropriately determining the compressive rigidity of the rubber bushes, it is possible to obtain several different toe direction control characteristics as shown by dotted lines in Figure 2.

Referring to Figure 3, it will be noted that the side force F acts on the rear right wheel 3R form the road surface laterally inwardly as the vehicle passes a leftwardly curved path. In other words, the side force is produced to act on the laterally outboard wheel in the laterally inward direction. The solid line F=0 shows the position of the wheel where the wheel is not subjected to a side force. At this instance, the center plane of the wheel is located to a position shown by a line 0_1. When the wheel is subjected to a side force of a small value, the wheel is shifted to the position shown by a broken line F=small. Thus, a toe-in movement is produced in the wheel. The center plane of the wheel is located at a position shown by a line 0_2. When the wheel is subjected to a side force of a medium value, the wheel is shifted to the position shown by a broken line F=medium to produce a toe-out movement. The center plane of the wheel is located at a position shown by a line 0_3. When the side force is large, the wheel is shifted to the position shown by a dotted line F = large to produce a toe-in movement. The center plane of the wheel is located at a position shown by a line 0_4 in Figure 3.

It will be noted in Figure 3 that the rear wheel 3R is directed straight forward when the wheel is not subjected to a side force. When the wheel is subjected to a side force of a small value, the bush 8R in the front link 4R is deflected by a greater extent than in the bush 10R in the rear link 5R. This will cause a toe-in movement of the wheel as described above to thereby ensure a running stability on a straight road. Under a side force of a medium value, the bush 8R of the front link 4R deflects by a smaller extent than in the bush 10R of the rear link 5R. Therefore, a toe-out movement is produced in the wheel 3R so that a turning operation of a small radius is made possible. Under a side force of a large value, the deflection of the front bush 8R again becomes larger than that in the rear bush 10R. Thus, a toe-in movement is produced in the wheel ensuring a running stability under a high speed cornering or in a lane changing operation.

Referring now to Figure 5, it will be noted that the front inner bush 8R is constituted by an inner sleeve 21 and an outer tube 22 which are concentric with each other. Between the inner sleeve 21 and the outer tube 22, there is a cylindrical rubber member 23 which is connected at the inner surface with the sleeve 21 and at the outer surface with the outer tube 22. The lateral link 4R is connected at the inner end with the outer tube 22 of the bush 8R.

The outer bush 12R on the front link 4R has the same structure as in the bush 8R so that corresponding parts are designated by the same reference numerals. The only difference is that the rubber member 23 in the inner bush 8R is formed with cutouts 24 at diametrically opposite positions. Figures 6 and 7 show the structure of the bush 12R whereas Figures 8 and 9 show the structure of the bush 8R. Further, Figures 10 and 11 show the structure of the bush 10R. It should be noted that the bush 14R for the rear link 5R is the same in structure as the bush 12R. The bush 10R for the rear link 5R is similar to the bush 8R for the front link 4R, however, as shown in Figures 8 and 9, the bush 8R is formed at an axially intermediate portion of each cutout 24 with a recess 25 which is not formed in the member 23 of the bush 10R as shown in Figures 10 and 11. The rubber member 23 of the bush 10R is made of a material which is harder than that of the material of the rubber member 23 in the bush 8R so that the rate of deflection in the bush 10R is smaller than that in the bush 8R as long as the side force is smaller than the value S-1. As the side force increases beyond the value S-1, the rubber member 23 in the bush 8R is deflected to such an extent that the cutout 24 is filled by the rubber material in the member 23. Thus, the rate of deflection in the bush 8R is decreased to a value smaller than that of the bush 10R. Under the side force greater than the value S-2, the rubber material in the member 23 of the bush 10R is deflected to such an extent that the cutout 24 is filled by the material in the member 23. Thus, the rate of deflection of the bush 10R increases. Since the rubber member 23 in the bush 8R has a recess 25, the deflection rate is larger in the bush 8R than in the bush 10R.

Figure 12 shows another type of vehicle rear suspension mechanism to which the present invention can be applied. In the mechanism shown in Figure 12, the lateral links 4L and 5L are arranged that the laterally inner bushes 8L and 10L are longitudinally spaced apart by a distance greater than the distance between the laterally outer bushes 12L and 14L.

In Figure 13, there is shown a further example of the suspension mechanism to which the present invention can be applied. In this structure, an upper lateral link 31L is provided in addition to the lateral links 4L and 5L. Further, the tension rod 17L is in the form of a thin plate having a width extending in the vertical direction.

Referring to Figure 14, there is shown a further different type of suspension mechanism to which the present invention can be applied. In this structure, an upper link 32R of a bifurcated shape is provided in addition to the lateral links 4R and 5R. The present invention can be applied to these suspension mechanisms as in the suspension mechanism shown in Figure 1.

Referring to Figure 15, there is shown another embodiment of the present invention in which the deflection property shown in Figure 4 is obtained in a different manner. In the structure shown in Figure 15, the laterally inner bush 8R of the front lateral link 4R is mounted on a bracket 28R provided on the sub-frame 1 by means of a pin or bolt 7R which has an axis inclined laterally inwardly toward forward with respect to the longitudinal axis of the vehicle body. At the front end, the outer tube 22 of the bush 8R is formed with a flange 22a and the rubber member 23 has an end flange 23a which is laid over the flange 22a on the outer tube 22. The front end surface of the flange 23a on the rubber member 23 is located with a gap l_1 with respect to a front flange 41 of the bracket 28R.

The laterally inner bush 10R on the rear lateral link 5R has a structure similar to the bush 8R and the pin or bolt 9R for installing the bush 10R on the bracket 29R is inclined as in the case of the bolt 7R for the bush 10R. The flange 23a of the rubber member 23 in the bush 10R is located with respect to the front flange 41 of the bracket 29R with a gap l_2. The gap l_2 is larger than the gap l_1. Further, the rubber member 23 in the front bush 8R is of a lower shear rigidity than the rubber member 23 in the rear bush 10R. In this embodiment, the rubber members 23 in the bushes 8R and 10R may have solid cylindrical portions without the cutouts as provided in the previous embodiments.

In this embodiment, when the side force F is applied as shown, the bushes 8R and 10R produce shearing deformations along the axes of the bolts 7R and 9R. Since the front bush 8R has a lower shearing rigidity than the rear bush 10R, the deformation in the front bush 8R is larger than that in the rear bush 10R. Under the side force beyond the value S-1, the flange 23a of the rubber member 23 in the front bush 8R abuts the flange 41 in the bracket 28R. In this instance, the rubber member 23 in the bush 8R produces a compressive deformation under the side force so that the rigidity is increased to a value greater than the shearing rigidity of the rear bush 10R. Under the side force F greater than the value S-2, the flange 23a of the rubber member 23 in the rear bush 10R abuts the flange 41 of the bracket 29R so that the bush produces a compressive deformation under the side force. Thus, the rigidity of the rear bush 10R is increased to a value greater than that of the front bush 8R.

Referring to Figure 16, the embodiment shown therein includes a link support mechanism 50 which includes an outer tube 51 supported by the sub-frame 1 of the vehicle body. In the tube 51, there is an inner sleeve 52 which is coaxial with the outer tube 51. At the opposite ends of the outer sleeve 51, there are provided cylindrical rubber members 53 and 54, respectively, which are formed with cutouts as in the bushes 8R and 10R shown in Figures 8 through 11. More specifically, the rubber member 53 is similar in shape to the member 23 in the bush 8R whereas the rubber member 54 is similar in shape to the member 23 in the bush 10R.

The inner sleeve 52 extends beyond the ends of the outer tube 51. A connecting rod 30 extends through the inner sleeve 52 and has opposite ends projecting beyond the ends of the sleeve 52. The rod 30 is provided at the opposite end portions with spherical bearings 33 and 34 which are secured to the rod 30 by means of pins 31 and retained by nuts 55 threaded into the opposite ends of the rod 30. The front lateral link 4R is mounted at the laterally inner end on the bearing 33 and the rear lateral link 5R is mounted at the laterally inner end on the bearing 34. The operations of the suspension system shown in Figure 16 are the same as in the embodiment shown in Figures 5 through 11.

Figure 17 is a diagram similar to Figure 4 but showing another example of the deflection properties of the bushes. In this example, the front bush 8R shows a greater deflection than the rear bush 10R as in the example of Figure 4 under the side force value S-1. At the side force value S-1, the deflection of the rear bush 10R is increased to a value larger than that of the front bush. With the side force greater than the value S-2, the front bush 8R shows a greater deflection than the rear bush 10R.

Figure 18 shows an example for obtaining the property shown in Figure 17. In this structure, the front inner bush 8R has a rubber member 23 which is formed at diametrically opposite positions with slots 24' of a certain radial dimensions. The slots 24' are filled with plastic plates 26 having radial dimensions larger than the radial dimensions of the slots 24' so that the rubber member 23 is applied with a precompression in the radial direction. The rear bush 10R has the same structure as the front bush 8R does. The rear bush 10R is applied with a precompression which is smaller than that of the front bush 8R. Further, the front outer bush 12R has a solid cylindrical rubber member 23 as well as the rear outer bush 14R does. It should however be noted that the rubber member 23 in the front bush 12R is of less compressive rigidity than in the rear bush 14R.

It will therefore be understood that with the side force smaller than the value S-1, the outer bushes produce compressive deflections and, due to the difference in the rigidity of the rubber members 23, the bush 12R shows a larger deflection than the bush 14R does. At the side force value S-1, the side force becomes equivalent to the precompression in the rubber member 23 of the rear bush 10R, so that the bush 10R starts to deflect under the side force together with the bush 14R. Thus, the lateral rigidity of the rear link 5R is decreased. With the side force greater than the value S-2, the side force is larger than the precompression force in the rubber member 23 of the front bush 8R. Thus, the front bush 8R is also deflected under the side force showing a lower rigidity.

Referring to Figure 19, it will be noted that the embodiment shown therein is substantially identical with the embodiment shown in Figure 1 so that corresponding parts are designated by the same reference numerals. In this embodiment, the right suspension mechanism includes a front lateral link assembly 4R which comprises an inner link rod 4R-1 and an outer link rod 4R-2 connected together by a connector 4R-3. The inner link rod 4R-1 has an inner end supported by the sub-frame 1 by means of a pin 7R and a front bush 8R as in the case of the front link 4R in the structure of Figure 1. The outer link rod 4R-2 is connected with the wheel hub 6R by means of a pin 13R and a rear bush 14R. In this embodiment, the bushes 8R and 12R have cylindrical rubber members although not specifically shown.

Referring to Figure 20, it will be noted that the connector 4R-3 includes an outer cylindrical case 41 integral with the outer end of the inner link rod 4R-1 and a piston 42 integral with the inner end of the outer link rod 4R-2. The piston 42 is disposed in the case 41 for axial slidable movement. The case 41 has an open outer end which is closed by an end cap 43. Between the end cap 43 and the piston 42, there is a cylindrical rubber member 44. In the case 41, there is a coil spring 45 which forces the piston laterally outwardly of the vehicle body. A rubber boot 46 may be provided to cover the sliding portion of the outer link rod 4R-2.

The suspension mechanism further includes a rear link assembly 5R which is similar in structure to the front link assembly 4R and includes an inner link rod 5R-1 and 1n outer link rod 5R-2 which are connected together by means of a connector 5R-3. The inner link rod 5R-1 has an inner end connected with the sub-frame 1 through a pin 9R and a bush 10R. The outer link rod 5R-2 has an outer end connected with the wheel hub 6R through a pin 13R and a bush 14R. The connector 5R-3 is identical in structure with the connector 4R-3. The bushes 10R and 14R have solid cylindrical rubber members as in the bushes 8R and 12R.

In the embodiment being described, the rubber members of the outer bushes 12R and 14R have the same compressive rigidity to provide the same deflection property. The rubber member in the front inner bush 8R has a lower rigidity than that of the rubber member in the rear inner bush 10R. The spring 45 in the connector 4R-3 is stronger than the spring 45 in the connector 5R-3. Therefore, in operation, the front inner bush 8R produces a greater deflection under a side force in the range where the side force is smaller than the value S-1. With the side force value of S-1, the connector 5R-3 starts to deflect so that the deflection rate at the rear link assembly 5R becomes larger than that in the front link assembly 4R. With the side force value greater than S-2, the connector 4R-3 produces a deflection so that the deflection rate in the front link assembly 4R becomes larger than that of the rear link assembly 5R.

Figure 21 shows a modification of the embodiment shown in Figure 16. In this embodiment, the rubber member 53 is applied with a precompression by inserting plastic plates 56 as in the embodiment of Figure 18. Similarly, the rubber member 54 in the rear end of the outer tube 51 is also applied with a precompression. By properly determining the precompressions in the front and rear rubber members 53 and 54, and the rigidity of the laterally outer bushes on the links 4R and 5R, it is possible to obtain the deflection property as shown in Figure 17.

Referring to Figure 22, there is shown another example of the deflection property of the rubber bushes. In this example, the front bush 8R deflects proportionally with the side force. The rear bush 10R deflects with a lower rate than the front bush with the side force smaller than the value S-1. With the side force between the values between S-1 and S-2, the rear bush 10r shows a higher deflection rate than the front bush 8R. Under the side force greater than the value S-2, the rear bush 10R shows a deflection rate lower than that in the front bush 8R.

In Figure 23, there is shown one example of the laterally inner bush 10R on the rear lateral link 5R for obtaining the property shown in Figure 22. In this embodiment, the rubber member 23 in the bush 10R is formed with a slot 124 of an arcuate cross-sectional configuration. At the side diametrically opposite to the slot 124, the rubber member 23 is further formed with cutouts 128 and 129. The other bushes 8R, 12R and 14R have solid cylindrical rubber members. In the area 125 between the cutouts 128 and 129, the rubber material is applied with a precompression. Due to the precompression, the rubber member 23 in the bush 10R is shows a larger rigidity than the rubber member in the front bush 8R does so that the bush shows a smaller deflection rate or a greater rigidity than the bush 8R does until the side force increases to a value corresponding to the precompression of the rubber material in the area 125. With the side force between the values S-1 and S-2, the precompression in the area 125 is relieved so that the rigidity of the rubber member 23 is decreased and the rubber member 23 deflects by having the slot 124 crashed so that the bush 10R shows a larger deflection rate than the bush 8R. With the side force greater than the value S-2, the slot 124 is filled with the rubber material so that the bush 10R shows a greater rigidity or a smaller deflection rate.

In the embodiment shown in Figure 24, the rubber member 23 or the rear inner bush 10R is applied with a precompression by means of an insert plastic plate 126.

Referring to Figure 25, the embodiment shown therein is substantially similar to that shown in Figure 1 so that corresponding parts are shown by the same reference numerals. In this embodiment, the suspension mechanism includes a rear lateral link assembly 5R which is comprised of an inner link rod 5R-1 and an outer link rod 5R-2 which are connected together by a connector 5R-3. The bushes 8R, 10R, 12R and 14R have solid cylindrical rubber members. The outer bushes 12R and 14R have the same compressive rigidity or the deflection property. The inner front bush 8R is of less compressive rigidity than the inner rear bush 10R.

Referring to Figure 26, it will be noted that the connector 5R-3 includes a cylindrical case 141 integral with the inner link rod 5R-1 which is formed at an axial intermediate portion with a stepped shoulder 141a. In the axial inner portion with respect to the shoulder 141a, there is formed a small diameter portion whereas a large diameter portion is formed in the axial outer portion of the shoulder 141a. A piston 142 integral with the outer link 5R-2 is slidably engaged with the large diameter portion. A coil spring 145 is provided for biasing the piston 142 laterally outwardly of the vehicle body. The outer end of the case 141 is opened and an end cap 143 is attached to the open end. Between the end cap 143 and the piston 142, there is a cylindrical rubber member 144. A flexible boot 146 is provided to cover the sliding portion of the outer link rod 5R-2. As shown in Figure 26, the piston 142 has a gap l with respect to the shoulder 141a when the side force is not applied to the lateral link assembly 5R.

In operation, when the side force is smaller than the value S-1, the side force is smaller than the precompression of the spring 145 so that the deflection is produced only in the bushes 8r, 10R, 12R and 14R. Since the bush 8R is of a less rigidity than the bush 10R, the deflection rate in the rear link assembly 5R is smaller than that in the front link 4R. With the side force between the values S-1 and S-2, the side force is greater than the precompression of the spring 145 so that the spring 145 is deflected. Thus, the rear link assembly 5R shows a greater deflection than the front link 4R does. At the side force value of S-2, the piston abuts the shoulder 141a so that deflections are produced only in the bushes 10R and 14R in relation to the rear link assembly 5R. It will therefore be understood that the deflection in the rear link assembly 5R is again increased to a value larger than that in the front link 4R as shown in Figure 22.

Referring to Figure 27, there is shown a modification of the connector 5R-3. In this embodiment, the spring 145 in the previous embodiment is substituted by a rubber block 145' which is arranged in position with a precompression and the piston 142 is in abutting engagement with the rubber block 145'. A stopper plate 141' is provided with a gap l with respect to the end surface of the piston 142. The function of the connector shown in Figure 27 is the same as that of the connector 5R-3.

In the embodiment shown in Figure 25, the front link 4R may be inclined outwardly toward rearward as shown by phantom lines so that an extension of the front link 4R intersects an extension of the rear link assembly 5R at a point P. With this arrangement, the side force produces a toe-in movement in the wheel because of the geometrical relationship so that the aforementioned function can be further promoted.

It will be noted that the structure of the rubber member shown in Figures 23 or 24 can be used in the place of the rubber members 54 of the structure shown in Figure 16. In this instance, the front rubber member 53 in Figure 16 is substituted by a solid cylindrical member. By appropriately determining the rigidities of the rubber members, it is possible to obtain the deflection properties as shown in Figure 22.

Claims

1. A suspension system for a motor vehicle wheel comprising front and rear lateral link means (4, 5) pivoted to a vehicle frame (1) at their inner ends and pivoted to a wheel support (6) at their outer ends; front and rear resilient members (4.3, 5.3; 8, 10, 12, 14; 53, 54) connected to said front and rear lateral link means arranged to influence the toe characteristics of the wheel (13), the structure and/or elastic properties of said resilient members and their arrangement with respect to said link means (4, 5) being such that the extent of deflection of the wheel in the toe-in-direction in response to a transversely inwardly directed side force applied to the wheel changes as the side force acting on said wheel is increased,
characterised in that the extent of toe-in wheel deflection increases as the side force is increased until a predetermined magnitude (S1) of side force is reached, after which the extent of toe-in deflection decreases with increasing side force until a second predetermined magnitude (S2) of side force is reached, after which the extent of toe-in wheel deflection again increases with increasing side force.

2. A suspension system in accordance with claim 1 wherein the lateral link means comprise at least two lateral links (4, 5) extending substantially transversely to the vehicle frame (1), both links (4, 5) being arranged in spaced-apart relationship in the longitudinal direction of the vehicle frame (1) and being connected with the vehicle frame (1) and the wheel support (6), respectively, via mounting means comprised of at least some of said resilient members (4.3, 5.3; 8, 10, 12, 14; 53, 54) wherein the rigidities of the inner and outer resilient members (8, 10, 12, 14; 53, 54) of each link (4, 5) are selected

such that the overall rigidity is lower at the forwardly positioned link (4) than that at the other link (5) wherein at least one (8) of said resilient members (8, 12) of the forwardly positioned link (4) is provided with first means (24; l_1) for increasing or first means (24', 26; 53, 56) for decreasing said overall rigidity at side forces beyond the first predetermined magnitude (S1) and at least one (10) of said resilient members (10, 14) of the other link (5) is provided with second means (24; l_2) for increasing or second means (24', 26) for decreasing, respectively, said overall rigidity at side forces beyond the second predetermined magnitude (S2) of the side force.

3. A suspension system in accordance with claim 2, in which the resilient members are bushes (8, 10, 12, 14) each bush comprising a resilient insert (23; 53, 54).

4. A suspension system in accordance with claims 2 and 3 in which in case when the first and second means increase said overall rigidity said first means are slot means (24; l_1) formed in the resilient insert (23) in at least one resilient member (8) of the forwardly positioned link (4) and said second means are slot means (24; l_2) formed in the resilient insert (23) in at least one resilient member (10) of the other link (5).

5. A suspension system in accordance with claims 2 and 3 in which in case when the first and second means decrease said overall rigidity said first means are means (24'; 26; 56) provided in the resilient insert (23; 53) in at least one resilient member (8) of the forwardly positioned link (4) for applying a precompression and said second means are means (24', 26) provided in the resilient insert (23) in at least one resilient member (10) of the other link (5) for applying a precompression.

6. A suspension system in accordance with claim 1 wherein the lateral link means comprise at least two lateral links (4, 5) extending substantially transversely to the vehicle frame (1), both links (4, 5) being arranged in spaced-apart relationship in the longitudinal direction of the vehicle frame (1) and being connected with the vehicle frame (1) and the wheel support (6), respectively, via mounting means comprised of at least some of said resilient members (4.3, 5.3; 8, 10, 12, 14; 53, 54) wherein said at least some resilient members of the forwardly positioned link (4) and the other link (5), respectively, are their inner members (8, 10), the resilient inserts (23) of which are arranged with their longitudinal axis inclined laterally inwardly toward forward, stopper means (23a, 41) being provided in said resilient bushes (8, 10) of said inner members for limiting an axial deflection thereof at the forwardly positioned link (4) below the first predetermined magnitude (S1) of side force and at the second link (5) below the second predetermined magnitude (S2) of the side force.

7. A suspension system in accordance with one of the claims 2 to 6 in which at least one of the links (4, 5) is comprised of a laterally inner rod (4.1, 5.1) and laterally outer rod (4.2, 5.2) which are connected together by an intermediate resilient member (4.3, 5.3) which functions as one of said resilient members.

8. A suspension system in accordance with claim 7 in which said intermediate resilient member (4.3, 5.3) includes precompression means (45; 145; 145') for applying a predetermined compressive force.

9. A suspension system in accordance with claim 8 in which said precompression means includes a precompression spring (45; 145).

10. A suspension system in accordance with claim 1 wherein the lateral link means comprise at least two lateral links (4, 5) extending substantially transversely to the vehicle frame (1), both links (4, 5) being arranged in spaced-apart relationship in the longitudinal direction of the vehicle frame (1) and being connected with the vehicle frame (1) and the wheel support (6), respectively, via mounting means comprised of at least some of said resilient members (4.3, 5.3; 8, 10, 12, 14; 53, 54) wherein the rigidities of the resilient members (8,10, 12, 14) of each link (4, 5) are selected such that at the forwardly positioned link (4) the overall rigidity is substantially constant and at the other link (5) is larger than the constant overall rigidity at side forces above the second (S2) and below the first (S1) predetermined magnitude of the side force and smaller at side forces inbetween the two magnitudes (S1, S2) and wherein at least one of said resilient members of said other link (5) is provided with slot means (124, 128, 129) or means (126) for applying a precompression.

11. A suspension system in accordance with one of the claims 7 to 9 and claim 11 in which said other backwardly positioned link (5) includes the intermediate resilient member (5.3).

12. A suspension system in accordance with claim 8 or 9 and claim 11 in which said precompression means (145; 145') applies a precompressed load to a connection between the laterally inner and outer rods (5.1; 5.2) and to a stopper means (141a; 141a') for limiting a stroke of said intermediate resilient member (5.3) to a predetermined value.

13. A suspension system in accordance with anyone of the claims 2 to 12 in which an upper lateral link means (31; 32) is provided above said two lateral links (4, 5) to extend between the vehicle frame (1) and the wheel support (6).

14. A suspension system in accordance with claim 13 in which said upper lateral link means (32) is in the form of a bifurcated configuration.

15. A suspension system in accordance with claim 2 and any other of the claims 3 to 16 in which said forwardly positioned link (4) is arranged to incline laterally inwardly toward forward so that an extension thereof intersects (at P in Fig. 25) an extension of the other link (5) rearwardly of the rotation axis of the wheel (3).

16. A suspension system in accordance with one of the claims 2 to 15 in which the two links (4, 5) are mounted at their transversely inner end portions on said vehicle frame (5) through a longitudinally extending rod (30), said resilient members (53, 54) being provided on said rod (30).

Revendications

1. Système de suspension pour une roue de véhicule automobile comprenant des moyens formant bras transversaux (4, 5) avant et arrière articulés sur le châssis (1) du véhicule au droit de leurs extrémités intérieures et articulés sur un support de roue (6) au droit de leurs extrémités extérieures ; des éléments élastiques avant et arrière (4.3, 5.3 ; 8, 10, 12, 14 ; 53, 54) reliés auxdits moyens formant bras transversaux avant et arrière agencés pour influer sur les caractéristiques d'ouverture-pincement de la roue (13), la structure et/ou les propriétés élastiques desdits éléments élastiques et leur arrangement par rapport auxdits moyens formant bras transversaux (4, 5) étant tels que l'amplitude de l'excursion de la roue dans le sens du pincement en réponse à une force latérale dirigée transversalement vers l'intérieur appliquée à la roue varie lorsque la force latérale agissant sur ladite roue est augmentée, caractérisé en ce que l'amplitude de l'excursion de la roue dans le sens du pincement croît lorsque la force latérale s'accroît jusqu'à ce qu'on ait atteint une valeur prédéterminée (S1) de la force latérale, après quoi l'amplitude de l'excursion dans le sens du pincement décroît avec l'accroissement de la force latérale jusqu'à ce qu'on ait atteint une deuxième valeur prédéterminée (S2) de la force latérale, après quoi l'amplitude de l'excursion de la roue dans le sens du pincement croît de nouveau avec l'accroissement de la force latérale.

2. Système de suspension selon la revendication 1, dans lequel les moyens formant bras transversaux comprennent aux moins deux bras transversaux (4, 5) qui s'étendent sensiblement transversalement au châssis (1) du véhicule, les deux bras (4, 5) étant disposés dans des positions espacées dans la direction longitudinale du châssis (1) du véhicule et étant reliés respectivement au châssis (1) du véhicule et au support de roues (6) par l'intermédiaire de moyens de montage composés d'au moins certains desdits éléments élastiques (4.3, 5.3 ; 8, 10, 12, 14 ; 53, 54), dans lequel les rigidités des éléments élastiques intérieurs et extérieurs (8, 10, 12, 14 ; 53, 54) de chaque bras (4, 5) sont choisies de telle manière que la rigidité globale soit inférieure dans le bras (4) positionné en avant que dans l'autre bras (5), dans lequel au moins un (8) desdits éléments élastiques (8, 12) du bras (4) placé à l'avant est muni de premiers moyens (24 ; l_1) qui augmentent ladite rigidité globale, ou de premiers moyens (24', 26 ; 53, 56) qui la réduisent en réponse à des forces latérales qui excèdent ladite valeur prédéterminée (S1) et au moins l'un (10) desdits éléments élastiques (10, 14) de l'autre bras (5) est muni de deuxièmes moyens (24 ; l_2) qui augmentent ladite rigité gloable, ou de deuxièmes moyens (24', 26) qui la réduisent, respectivement, en réponse à des forces latérales situées au-delà de la deuxième valeur prédéterminée (S2) de la force latérale.

3. Système de suspension selon la revendication 2, dans lequel les éléments élastiques sont des bagues (8, 10, 12, 14), chaque bague comprenant un insert élastique (23 ; 53, 54).

4. Système de suspension selon les revendications 2 et 3, dans lequel, dans le cas où les premiers et deuxièmes moyens augmentent ladite rigidité globale, lesdits premiers moyens sont des fentes (24 ; l_1) formées dans l'insert élastique (23) contenu dans au moins un élément élastique (8) du bras (4) placé en position avant et lesdits deuxièmes moyens sont des moyens du type fente (24 ; l_2) formés dans l'insert élastique (23) contenu dans au moins un élément élastique (10) de l'autre bras (5).

5. Système de suspension selon les revendications 2 et 3, dans lequel, dans le cas où les premiers et deuxièmes moyens augmentent ladite rigidité globale, lesdits premiers moyens sont des moyens (24' ; 26 ; 56) prévus dans l'insert élastique (23 ; 53) contenu dans au moins un élément élastique (8) du bras (4) placé en position avant pour appliquer une précompression, et lesdits deuxièmes moyens sont des moyens (24', 26) prévus dans l'insert élastique (23) contenu dans au moins un élément élastique (10) de l'autre bras (5) pour appliquer une précompression.

6. Système de suspension selon la revendication 1, dans lequel les moyens formant bras transversaux comprennent au moins deux bras transversaux (4, 5) qui s'étendent sensiblement transversalement au châssis (1) du véhicule, les deux bras (4, 5) étant agencés dans des positions relatives espacées dans la direction longitudinale du châssis (1) du véhicule et étant reliés au châssis (1) du véhicule et au support de roue (6) respectivement par l'intermédiaire de moyens de montage composés d'au moins certains desdits éléments élastiques (4.3, 5.3 ; 8, 10, 12, 14 ; 53, 54), dans lequel lesdits au moins certains éléments élastiques du bras (4) placé en position avant et de l'autre bras (5) respectivement sont leurs éléments intérieurs (8, 10), dont les inserts élastiques (23) sont agencés avec leur axe longitudinal incliné transversalement vers l'intérieur et vers l'avant, des moyens de butée (23a, 41) étant prévus dans lesdites bagues élastiques (8, 10) desdits éléments intérieurs pour limiter la déformation axiale de ces bagues au droit du bras (4) placé en position avant au-dessous de la première valeur prédéterminée (S1) de la force latérale, et au droit du deuxième bras (5) au-dessous de la deuxième valeur prédéterminée (S2) de la force latérale.

7. Système de suspension selon une des revendications 2 à 6, dans lequel au moins l'un des bras (4, 5) est composé d'une barre transversalement intérieure (4.1, 5.1) et d'une barre transversalement extérieure (4.2, 5.2) qui sont assemblées l'une à l'autre par un élément élastique intermédiaire (4.3, 5.3) qui joue le rôle de l'un desdits éléments élastiques.

8. Système de suspension selon la revendication 7, dans lequel ledit élément élastique intermédiaire (4.3, 5.3) comprend des moyens de précompression (45 ; 145 ; 145') servant à appliquer une force de compression prédéterminée.

9. Système de suspension selon la revendication 8, dans lequel lesdits moyens de précompression comprennent un ressort de précompression (45 ; 145).

10. Système de suspension selon la revendication 1, dans lequel les moyens formant bras transversaux comprennent au moins deux bras transversaux (4, 5) qui s'étendent sensiblement transversalement au châssis (1) du véhicule, les deux bras (4, 5) étant disposés dans des positions relatives espacées dans la direction longitudinale du châssis (1) du véhicule et étant reliés au châssis (1) du véhicule et au support de roue (6), respectivement par l'intermédiaire de moyens de montage composés d'au moins certains desdits éléments élastiques (4.3, 5.3 ; 8, 10, 12, 14 ; 53, 54), dans lequel les rigidités des éléments élastiques (8, 10, 12, 14) de chaque bras (4, 5) sont choisies de telle manière que, dans le bras (4) placé en position avant, la rigidité globale soit sensiblement constante et que, dans l'autre bras (5), elle soit plus grande que la rigidité globale constante en réponse à des forces latérales supérieures à la deuxième valeur (S2) prédéterminée de la force latérale ou inférieures à de cette première valeur, mais plus petite en présence de forces latérales comprises entre les deux valeurs (S1, S2), et dans lequel au moins un desdits éléments élastiques de l'autre bras (5) est muni de moyens du type fente (124, 128, 129) ou de moyens (126) servant à appliquer une précompression.

11. Système de suspension selon une des revendications 7 à 9 et selon la revendication 11, dans lequel ledit autre bras (5) placé en position arrière comprend l'élément élastique intermédiaire (5.3).

12. Système de supension selon la revendication 8 ou 9 ou selon la revendication 11, dans lequel lesdits moyens de précompression (145 ; 145') appliquent une charge de précompression à une liaison établie entre les barres transversalement intérieure et extérieure (5.1 ; 5.2) et à un moyen de butée (141a ; 141a') servant à limiter la course dudit élément élastique intermédiaire (5.3) à une valeur prédéterminée.

13. Système de suspension selon une quelconque des revendications 2 à 12, dans lequel un moyen formant bras transversal supérieur (31 ; 32) est prévu au-dessus desdits deux bras transversaux (4, 5) pour s'étendre entre le châssis (1) du véhicule et le support de roue (6).

14. Système de suspension selon la revendication 13, dans lequel ledit moyen formant bras transversal supérieur (32) est en forme de fourche.

15. Système de suspension selon la revendication 2 et une quelconque des autres revendications 3 à 16, dans lequel ledit bras (4) placé en position avant est agencé pour s'incliner transversalement vers l'intérieur et vers l'avant, de manière que son prolongement coupe (en P sur la figure 25) le prolongement de l'autre bras (5) en arrière de l'axe de rotation de la roue (3).

16. Système de suspension selon une des revendications 2 à 15, dans lequel les deux bras (4, 5) sont montés, au niveau de leurs parties d'extrémités transversalement intérieures sur ledit châssis (5) du véhicule par l'intermédiaire d'une barre (30) s'étendant longitudinalement, lesdits éléments élatiques (53, 54) étant prévus sur ladite barre (30).

Patentansprüche

1. Aufhängung für ein Fahrzeugrad mit vorderen und hinteren Querlenkereinrichtungen (4, 5), die mit ihren inneren Enden an einem Fahrzeugrahmen (1) angelenkt sind und mit ihren äußeren Enden an einem Radträger (6) angelenkt sind; vorderen und hinteren elastischen Elementen (4.3, 5.3; 8, 10, 12, 14; 53, 54), die mit den vorderen und hinteren Querlenkereinrichtungen verbunden sind, angeordnet, um die Spureigenschaften des Rades (13) zu beeinflussen, wobei der Aufbau und/oder die elastischen Eigenschaften der elastischen Elemente und ihre Anordnung bezüglich der Lenkereinrichtungen (4, 5) dergestalt sind, daß das Ausmaß des Einschlags des Rades in der Vorspur-Richtung in Reaktion auf eine quer nach innen gerichtete Seitenkraft, die an das Rad angelegt ist, sich ändert, wenn die auf das Rad wirkende Seitenkraft ansteigt, dadurch gekennzeichnet, daß das Ausmaß des Vorspur-Radeinschlags ansteigt, wenn die Seitenkraft erhöht wird, bis eine bestimmte Größe (S1) der Seitenkraft erreicht ist, wonach das Ausmaß des Vorspur-Einschlags mit zunehmender Seitenkraft abnimmt, bis eine zweite vorbestimmte Größe (S2) der Seitenkraft erreicht ist, wonach das Ausmaß des Vorspur-Radeinschlags mit zunehmender Seitenkraft wieder ansteigt.

2. Aufhängung nach Anspruch 1, wobei die Querlenkereinrichtung wenigstens zwei Querlenker (4, 5) aufweist, die sich im wesentlichen quer zu dem Fahrzeugrahmen (1) erstrecken, wobei beide Lenker (4, 5) in voneinander beabstandeter Beziehung in Längsrichtung des Fahrzeugrahmens (1) angeordnet und mit dem Fahrzeugrahmen (1) bzw. dem Radträger (3) durch eine Befestigungseinrichtung verbunden sind, die wenigstens einige der elastischen Elemente (4.3, 5.3; 8, 10, 12, 14; 53, 54) umfaßt, wobei die Steifigkeiten der inneren und äußeren elastischen Elemente (8, 10, 12, 14; 53, 54) jedes Lenkers (4, 5) so gewählt sind, daß die Gesamtsteifigkeit an dem vorne angeordneten Lenker (4) geringer ist als an dem anderen Lenker (5), wobei wenigstens eines (8) der elastischen Elemente (8, 12) des vorne angeordneten Lenkers (4) versehen ist mit ersten Einrichungen (24; l_1) zum Erhöhen oder ersten Einrichtungen (24', 26; 53, 56) zum Senken der Gesamtsteifigkeit bei Seitenkräften jenseits der ersten vorbestimmten Größe (S1) und wenigstens eines (10) der elastischen Elemente (10, 14) des anderen Lenkers (5) versehen ist mit einer zweiten Einrichtung (24; l_2) zum Erhöhen oder einer zweiten Einrichtung (24', 26) zum Senken jeweils der Gesamtsteifigkeit bei Seitenkräften jenseits der zweiten vorbestimmten Größe (S2) der Seitenkraft.

3. Aufhängung nach Anspruch 2, wobei die elastischen Elemente Bürsten (8, 10, 12, 14) sind, wobei jede Bürste einen elastischen Einsatz (23; 53, 54) aufweist.

4. Aufhängung nach Anspruch 2 und 3, wobei in dem Fall, wenn die erste und zweite Einrichtung die Gesamtsteifigkeit erhöhen, die ersten Einrichtungen Schlitzeinrichtungen (24; l_1) sind, die in dem elastischen Einsatz (23) in wenigstens einem elastischen Element (8) des vorne angeordneten Lenkers (4) gebildet sind und die zweiten Einrichtungen Schlitzeinrichtungen (24; l_2) sind, die in den elastischen Einsätzen (23) in wenigstens einem elastischen Element (10) des anderen Lenkers (5) gebildet sind.

5. Aufhängung nach Anspruch 2 und 3, wobei in dem Fall, wenn die ersten und zweiten Einrichtungen die Gesamtsteifigkeit senken, die ersten Einrichtungen (24'; 26; 56) Einrichtungen sind, die in den elastischen Einsätzen (23; 53) in wenigstens einem elastischen Element (8) des vorne angeordneten Lenkers (4) vorgesehen sind, um eine Vorverdichtung anzulegen und die zweiten Einrichtungen (24', 26) Einrichtungen sind, die in den elastischen Einsätzen (23) in wenigstens einem elastischen Element (10) des anderen Lenkers (5) zum Anlegen einer Vorverdichtung vorgesehen sind.

6. Aufhängung nach Anspruch 1, wobei die Querlenkereinrichtung wenigstens zwei Querlenker (4, 5) aufweist, die sich im wesentlichen quer zum Fahrzeugrahmen (1) erstrecken, wobei beide Lenker (4, 5) in voneinander beabstandeter Beziehung in der Längsrichtung des Fahrzeugrahmens (1) angeordnet und mit dem Fahrzeugrahmen (1) bzw. dem Radträger (6) durch eine Befestigungseinrichtung verbunden sind, die wenigstens einige der elastischen Elemente (4.3, 5.3; 8, 10, 12, 14; 53, 54) aufweist, wobei die genannten elastischen Elemente des vorne angeordneten Lenkers (4) bzw. des anderen Lenkers (5) ihre inneren Elemente (8, 10) sind, wobei deren elastische Einsätze (23) so angeordnet sind, daß ihre Längsachsen quer einwärts nach vorne geneigt sind, wobei Stoppereinrichtungen (23a, 41) in den elastischen Bürsten (8, 10) der inneren Elemente vorgesehen sind, um deren axiale Biegung an dem vorne angeordneten Lenker (4) auf unterhalb der ersten vorbestimmten Größe (S1) der Seitenkraft zu begrenzen und an dem zweiten Lenker (5) auf unterhalb der zweiten vorbestimmten Größe (S2) der Seitenkraft zu begrenzen.

7. Aufhängung gemäß einem der Ansprüche 2 bis 6, wobei wenigstens einer der Lenker (4, 5) einen quergerichteten inneren Stab (4.1, 5.1) und einen quergerichteten äußeren Stab (4.2, 5.2) aufweist, die durch ein mittleres elastisches Element (4.3, 5.3) verbunden sind, welches als eines der elastischen Elemente dient.

8. Aufhängung nach Anspruch 7, wobei das mittlere elastische Element (4.3, 5.3) eine Vorverdichtungseinrichtung (45; 145; 145') aufweist, um eine vorbestimmte Verdichtungskraft anzulegen.

9. Aufhängung nach Anspruch 8, wobei die Vorverdichtungseinrichtung eine Vorverdichtungsfeder (45; 145) aufweist.

10. Aufhängung nach Anspruch 1, wobei die Querlenkereinrichtung wenigstens zwei Querlenker (4, 5) aufweist, die sich im wesentlichen quer zum Fahrzeugrahmen (1) erstrecken, wobei beide Lenker (4, 5) in voneinander beabstandeter Beziehung in der Längsrichtung des Fahrzeugrahmens (1) angeordnet und mit dem Fahrzeugrahmen (1) bzw. dem Radträger (6) verbunden sind, und zwar durch eine Befestigungseinrichtung, die wenigstens einige der elastischen Elemente (4.3, 5.3; 8, 10, 12, 14; 53, 54) aufweist, wobei die Steifigkeiten der elastischen Elemente (8, 10, 12, 14) jedes Lenkers (4, 5) so gewählt sind, daß an dem vorne angeordneten Lenker (4) die Gesamtsteifigkeit im wesentlichen konstant ist und an dem anderen Lenker (5) größer ist als die Gesamtsteifigkeit bei Seitenkräften über der zweiten (S2) und unter der ersten (S1) vorbestimmten Größe der Seitenkraft und kleiner bei Seitenkräften zwischen den zwei Größen (S1, S2) und wobei wenigstens eines der elastischen Elemente des anderen Lenkers (5) mit Schlitzeinrichtungen (124, 128, 129) oder Einrichtungen (126) zum Anlegen einer Vorverdichtung versehen sind.

11. Aufhängung nach einem der Ansprüche 7 bis 9 und Anspruch 11, wobei der andere hinten angeordnete Lenker (5) das mittlere elastische Element (5.3) aufweist.

12. Aufhängung nach Anspruch 8 oder 9 und Anspruch 11, wobei die Vorverdichtungseinrichtung (145; 145') eine vorverdichtete Last auf eine Verbindung zwischen den quergerichteten inneren und äußeren Stäben (5.1; 5.2) und auf eine Stoppereinrichtung (141a; 141a') aufbringt, um einen Hub des mittleren elastischen Elementes (5.3) auf einen vorbestimmten Wert zu begrenzen.

13. Aufhängung nach einem der Ansprüche 2 bis 12, wobei eine obere Querlenkereinrichtung (31; 32) über den zwei Querlenkern (4, 5) vorgesehen ist, und sich zwischen dem Fahrzeugrahmen (1) und dem Radträger (6) erstreckt.

14. Aufhängung nach Anspruch 13, wobei die obere Querlenkereinrichtung (32) in der Form einer gegabelten Konfiguration vorliegt.

15. Aufhängung nach Anspruch 2 und einem der Ansprüche 3 bis 16, wobei der vorne angeordnete Lenker (4) so angeordnet ist, daß er quer einwärts nach vorne geneigt ist, so daß seine Erweiterung (bei P in Figur 25) eine Erweiterung des anderen Lenkers (5) hinter der Drehachse des Rads (3) schneidet.

16. Aufhängung nach einem der Ansprüche 2 bis 16, wobei die zwei Lenker (4, 5) an ihren quergerichteten inneren Endteilen an dem Fahrzeugrahmen (5) durch einen längserstreckten Stab (30) befestigt sind, wobei die elastischen Elemente (53, 54) auf dem Stab (3) vorgesehen sind.

FIG. 1

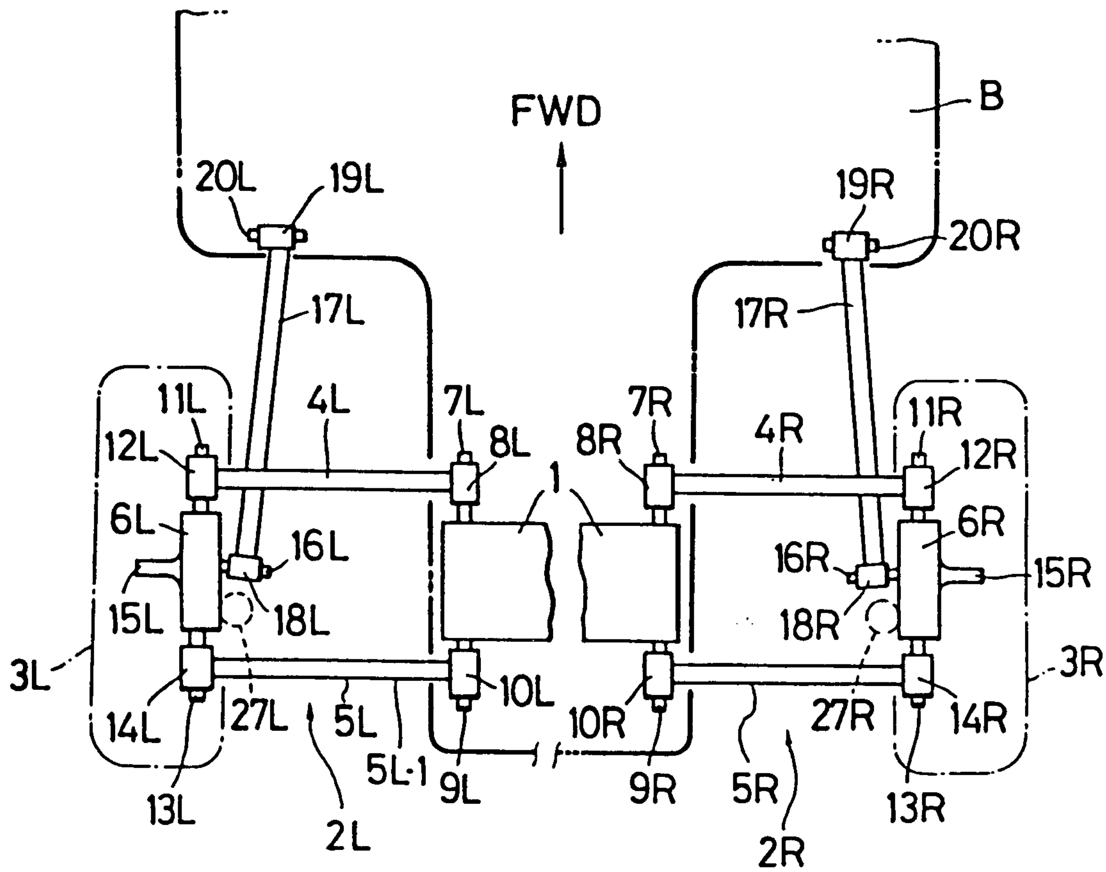

FWD
B
20L
19L
19R
20R
17L
17R
11L
4L
7L
7R
4R
11R
12L
8L
8R
1
12R
6L
6R
16L
16R
15R
15L
18L
18R
3L
3R
14L
27L
5L
10L
10R
27R
14R
5L-1
9L
9R
5R
13L
13R
2L
2R

FIG. 2

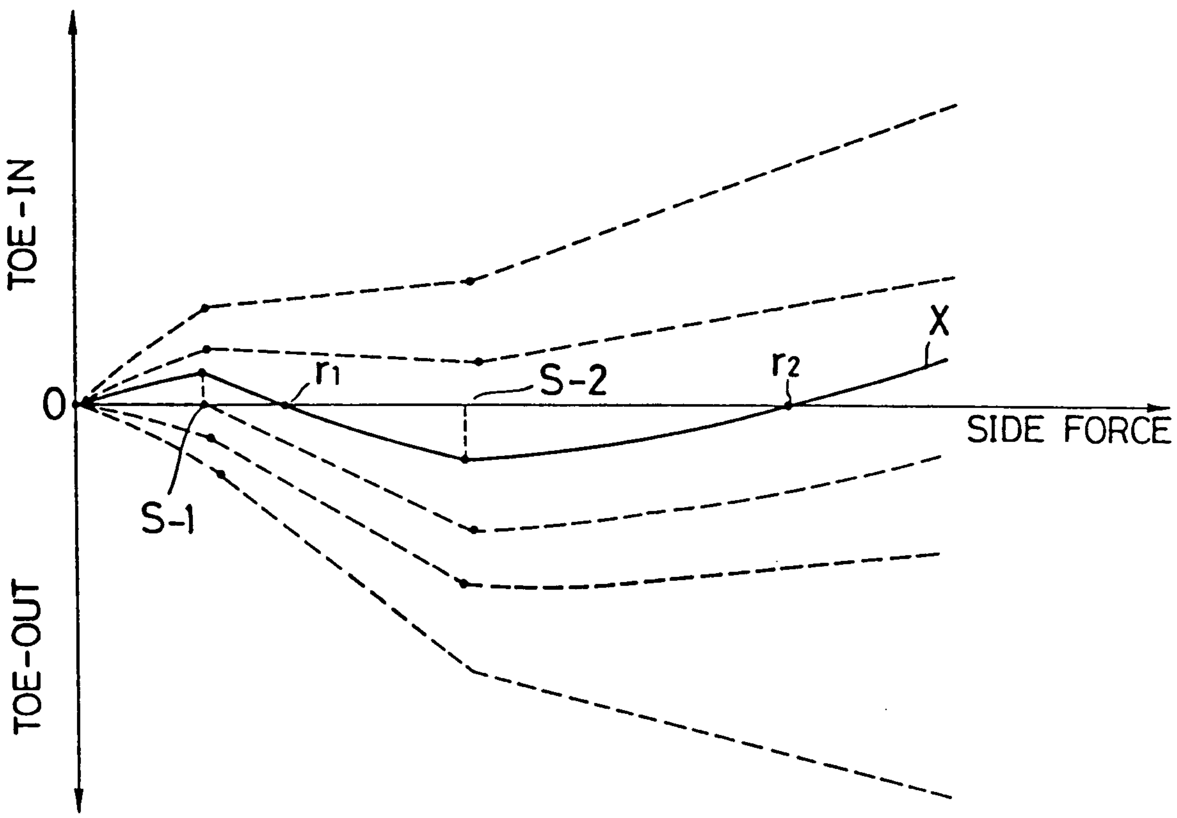


FIG.3

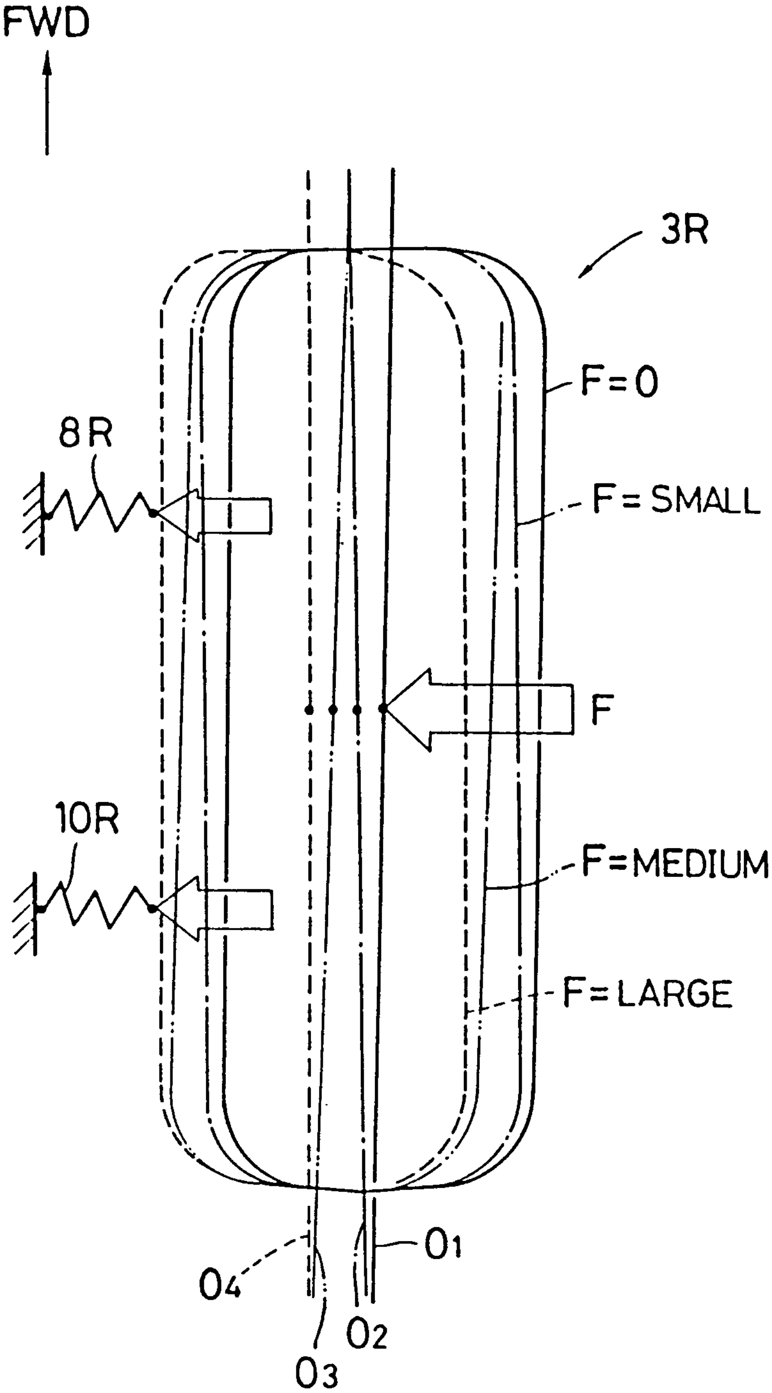


FIG.4

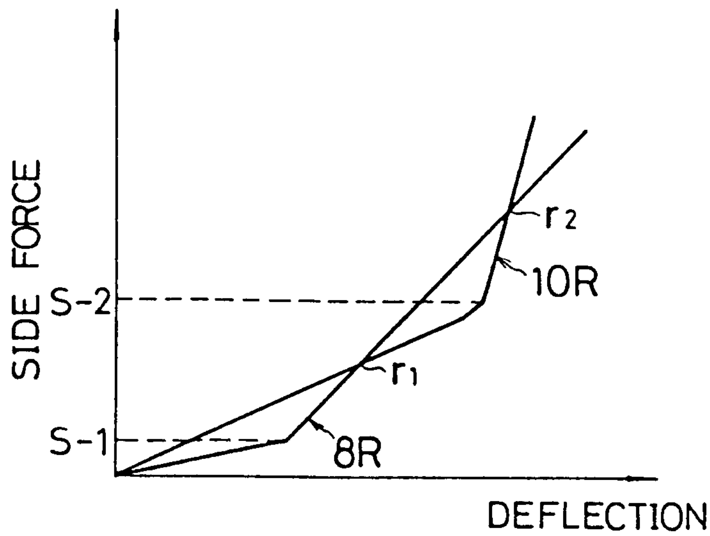

SIDE FORCE
S-2
S-1
r2
10R
r1
8R
DEFLECTION

FIG.5

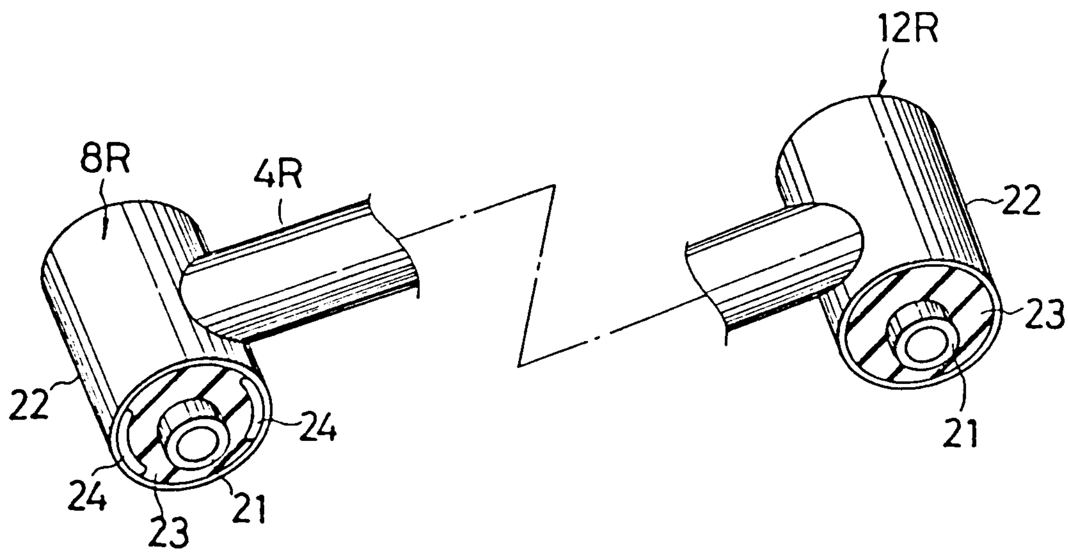

12R
8R
4R
22
22
23
24
24
23
21
21

FIG.6

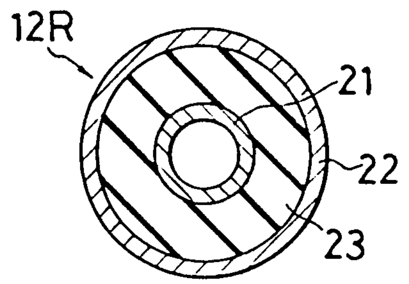


FIG.7

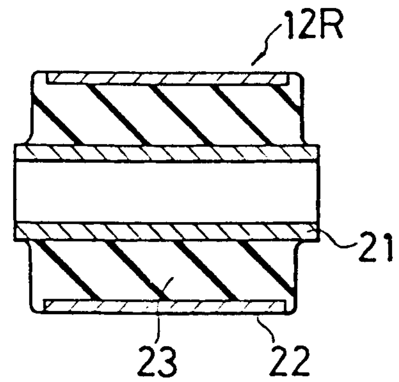


FIG.8

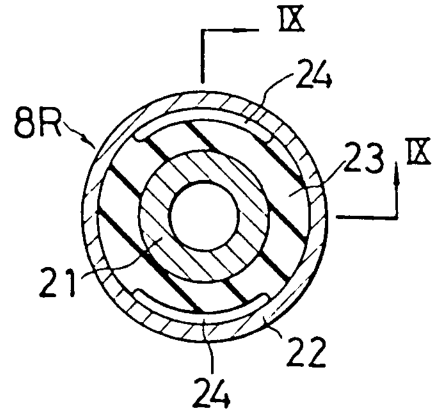


FIG.9

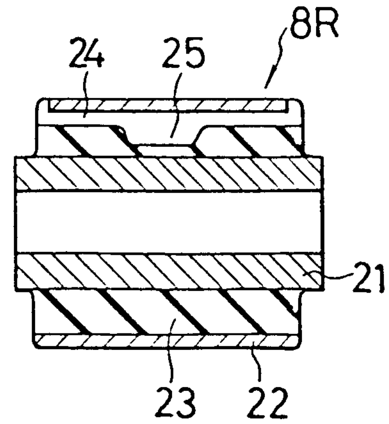


FIG.10

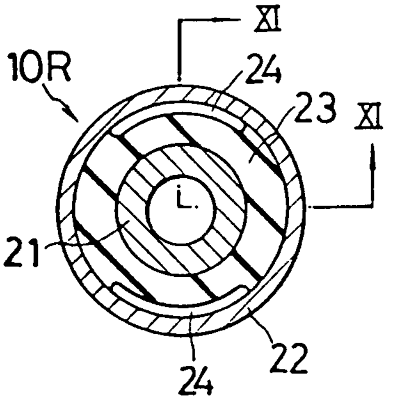


FIG.11

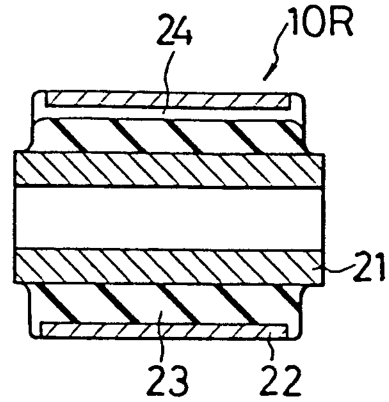


FIG.12

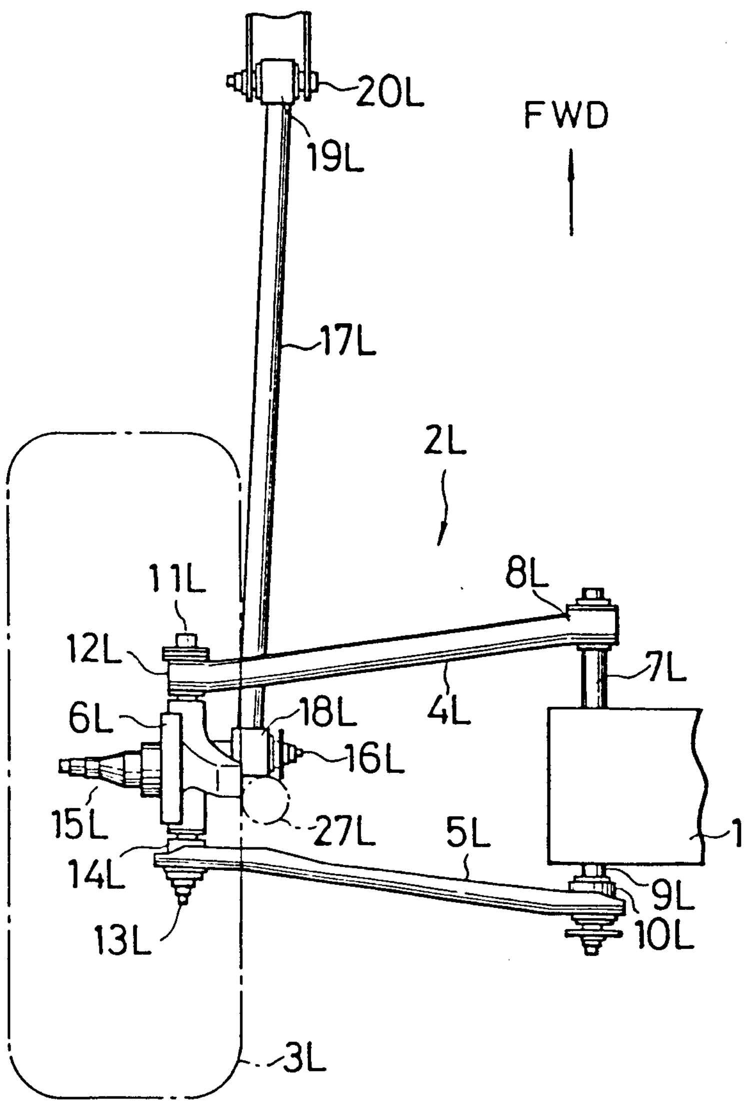


FIG.13

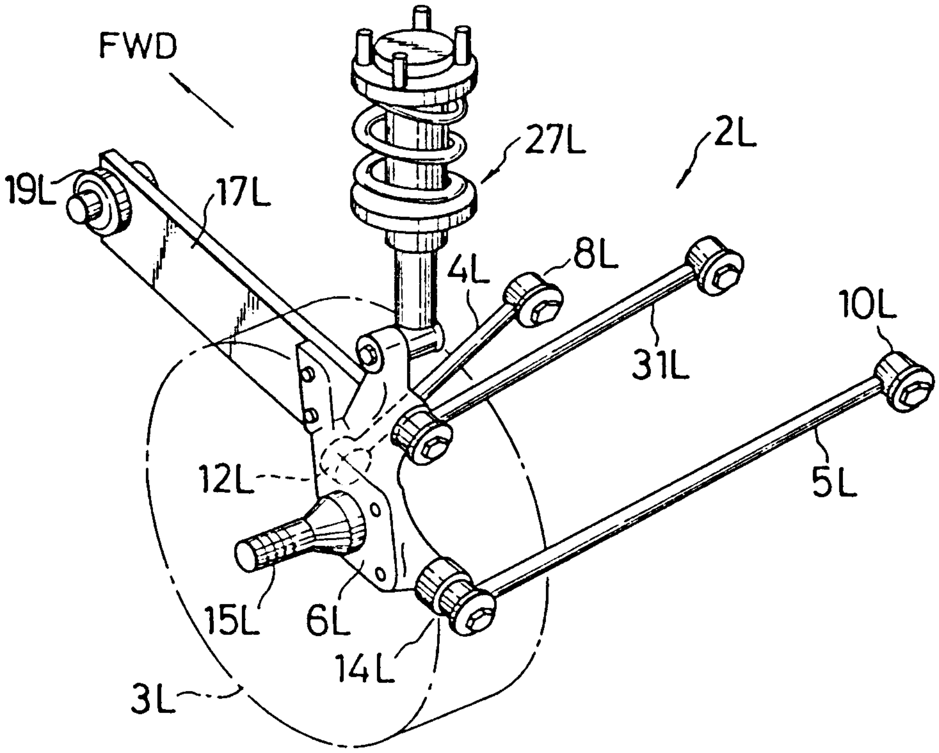

FWD
19L
17L
27L
2L
4L
8L
31L
10L
12L
5L
15L
6L
14L
3L

FIG.14

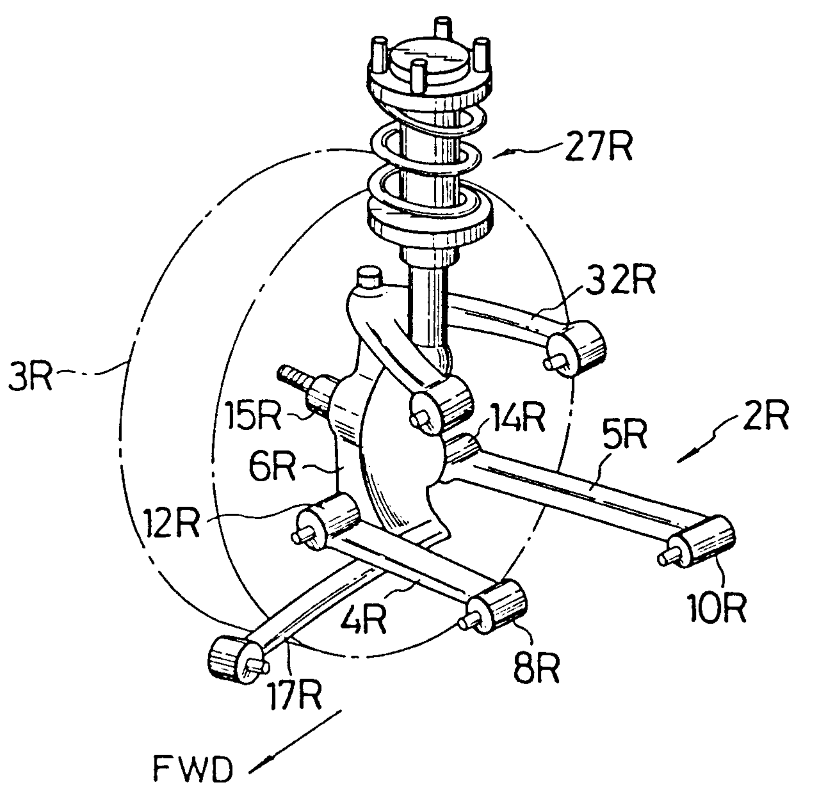

27R
32R
3R
15R
14R
5R
2R
6R
12R
10R
4R
8R
17R
FWD

FIG.15

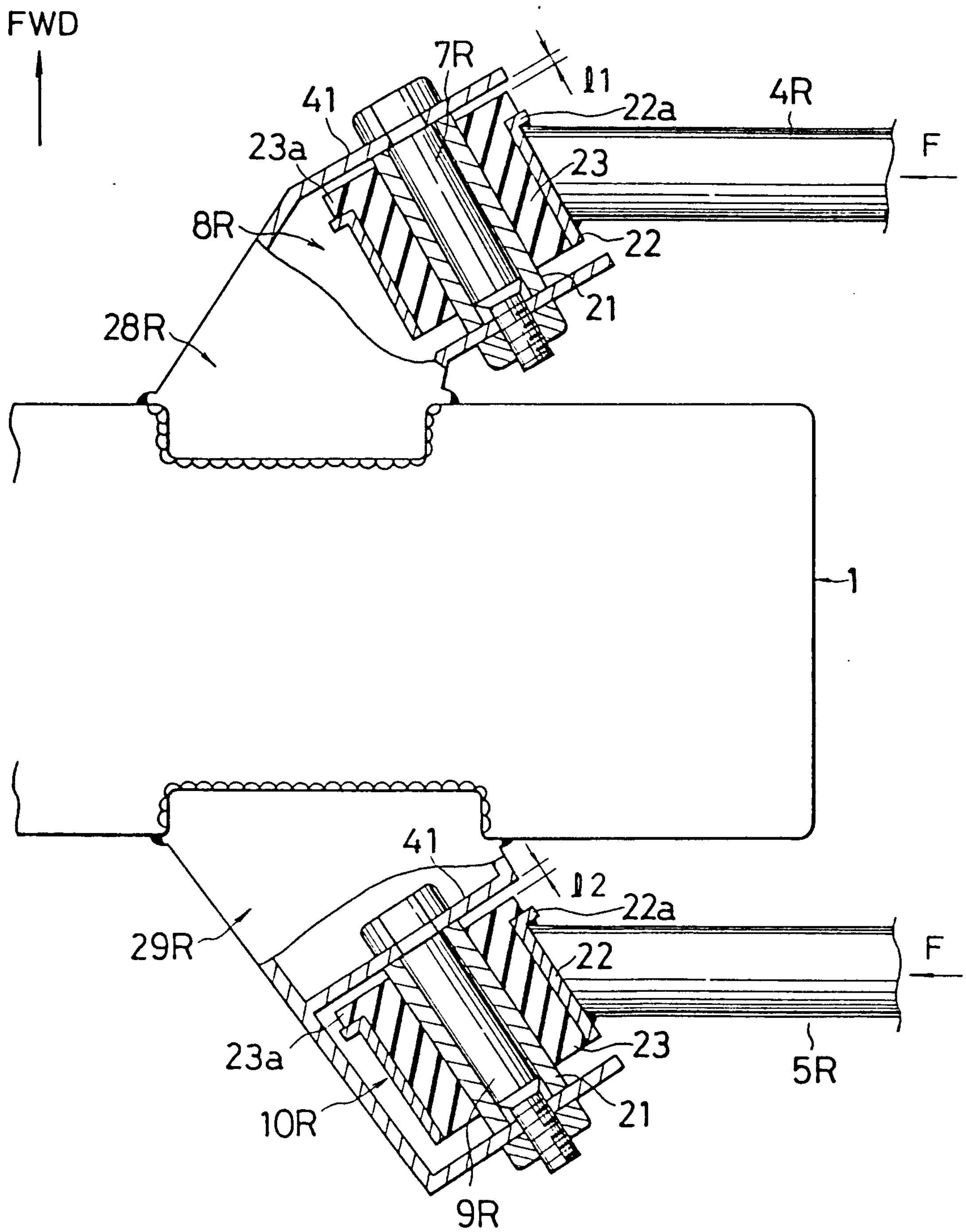

FWD
7R
ℓ1
41
22a
4R
23a
F
23
8R
22
21
28R
1
41
ℓ2
22a
29R
F
22
23a
23
5R
10R
21
9R

FIG.16

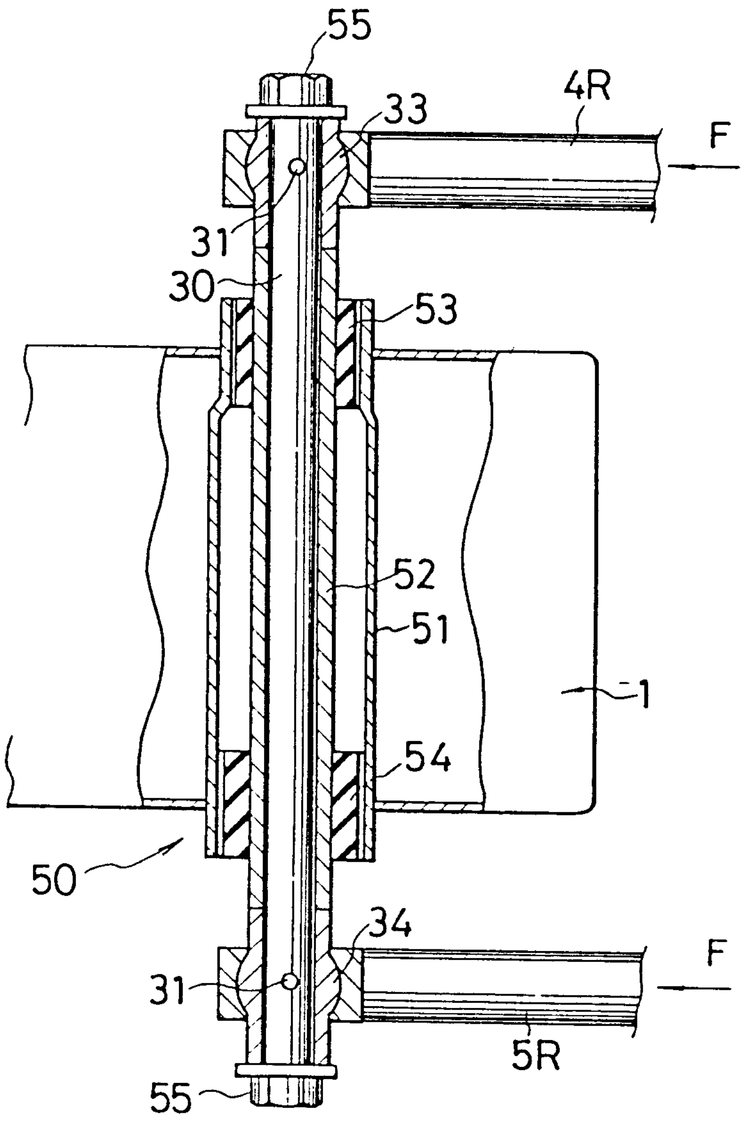


FIG.17

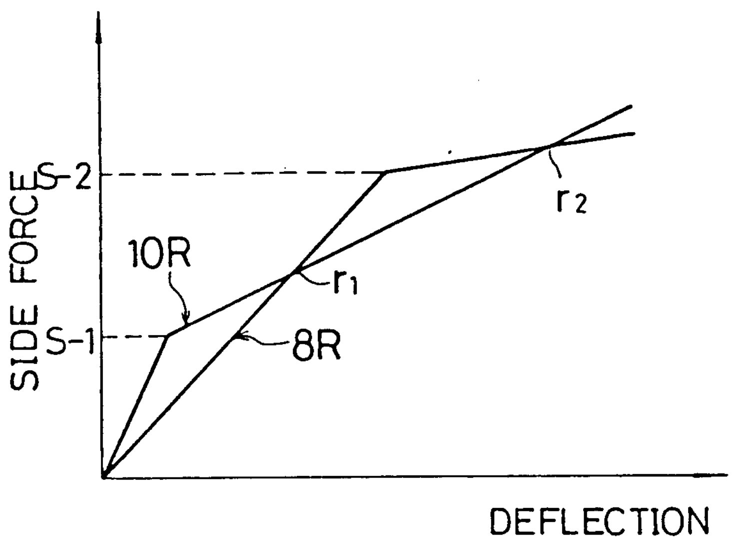

SIDE FORCE
S-2
S-1
10R
8R
r1
r2
DEFLECTION

FIG.18

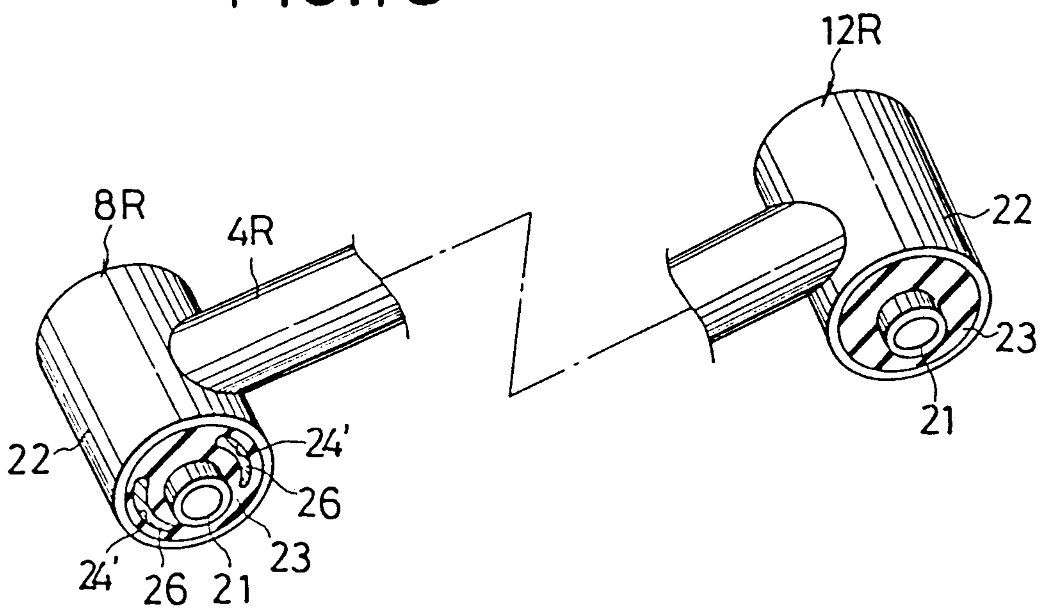

12R
8R
4R
22
23
21
24'
26
22
24'
26
21
23

FIG.19

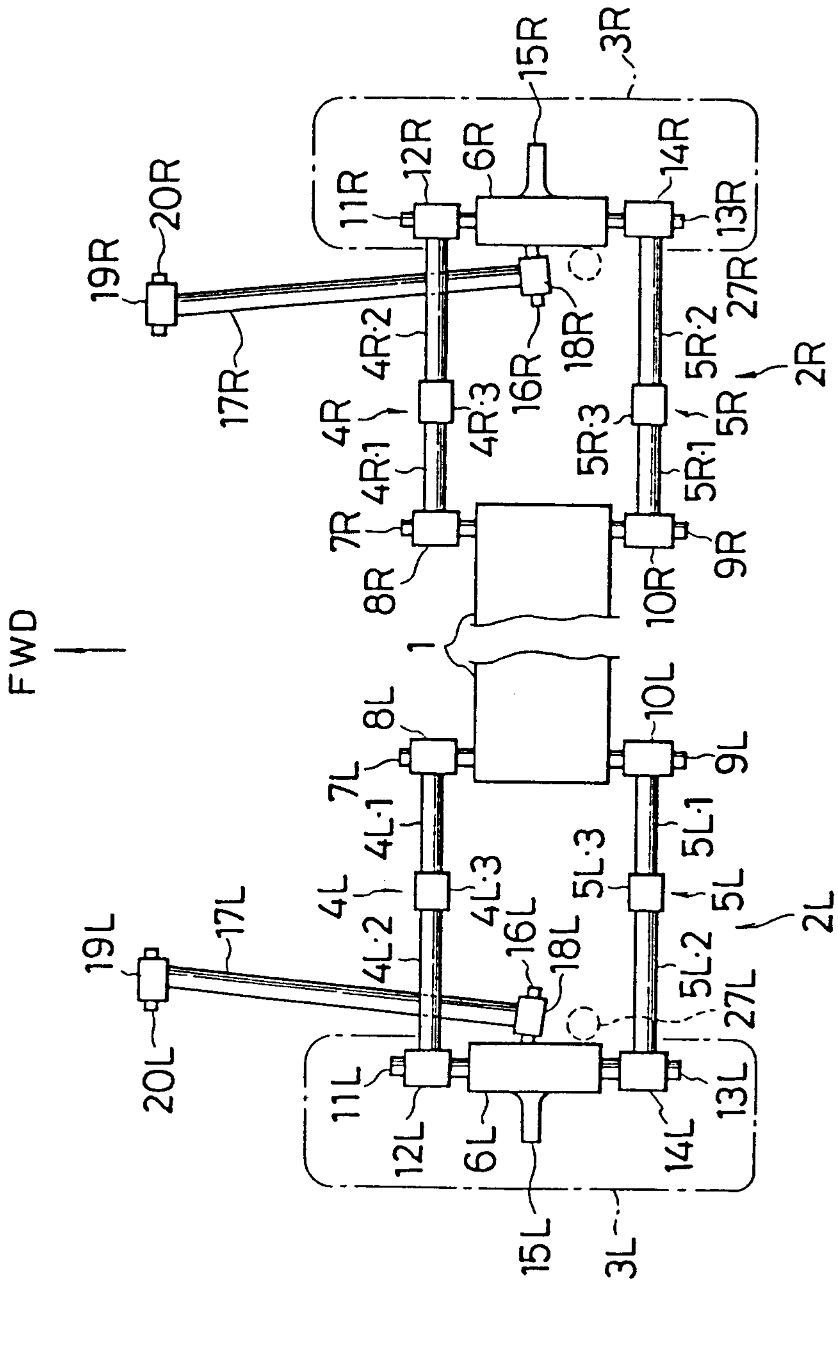

FWD
1
2L
2R
3L
3R
4L
4L·1
4L·2
4L·3
4R
4R·1
4R·2
4R·3
5L
5L·1
5L·2
5L·3
5R
5R·1
5R·2
5R·3
6L
6R
7L
7R
8L
8R
9L
9R
10L
10R
11L
11R
12L
12R
13L
13R
14L
14R
15L
15R
16L
16R
17L
17R
18L
18R
19L
19R
20L
20R
27L
27R

FIG.20

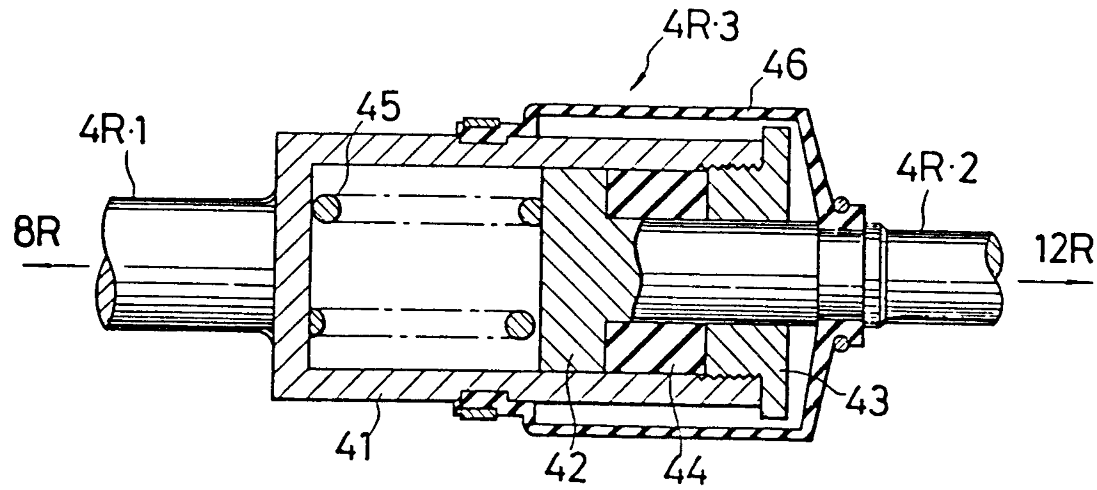


FIG.21

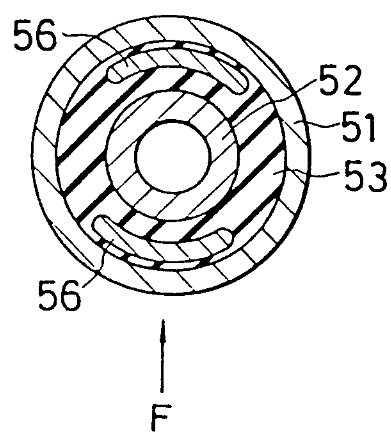


FIG.22

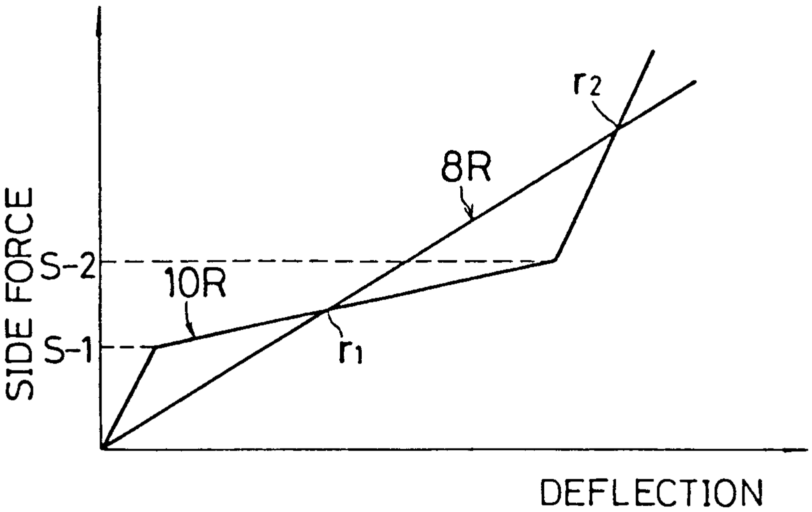


FIG.23

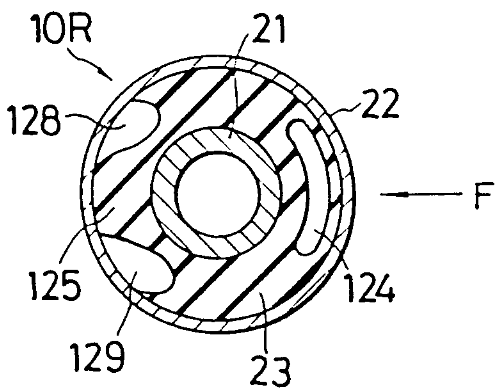


FIG.24

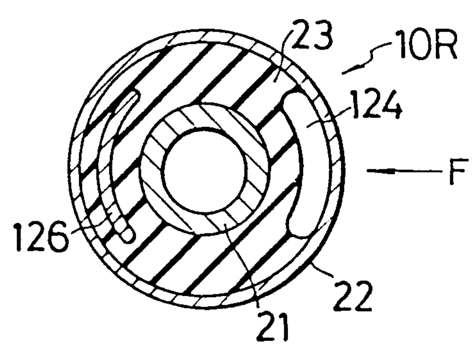


FIG.25

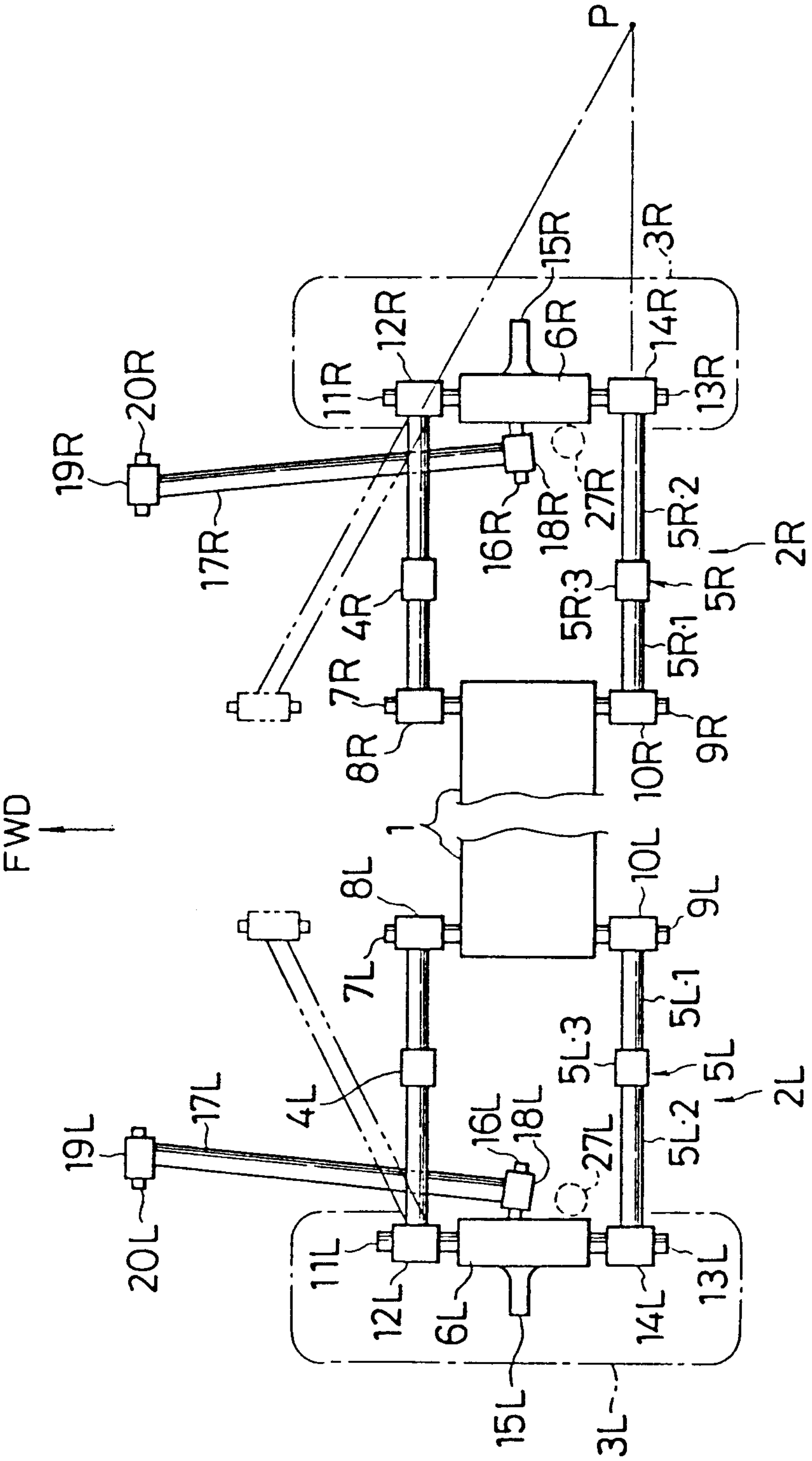

P
FWD
1
2R
3R
4R
5R
5R·1
5R·2
5R·3
6R
7R
8R
9R
10R
11R
12R
13R
14R
15R
16R
17R
18R
19R
20R
27R
2L
3L
4L
5L
5L·1
5L·2
5L·3
6L
7L
8L
9L
10L
11L
12L
13L
14L
15L
16L
17L
18L
19L
20L
27L

FIG.26

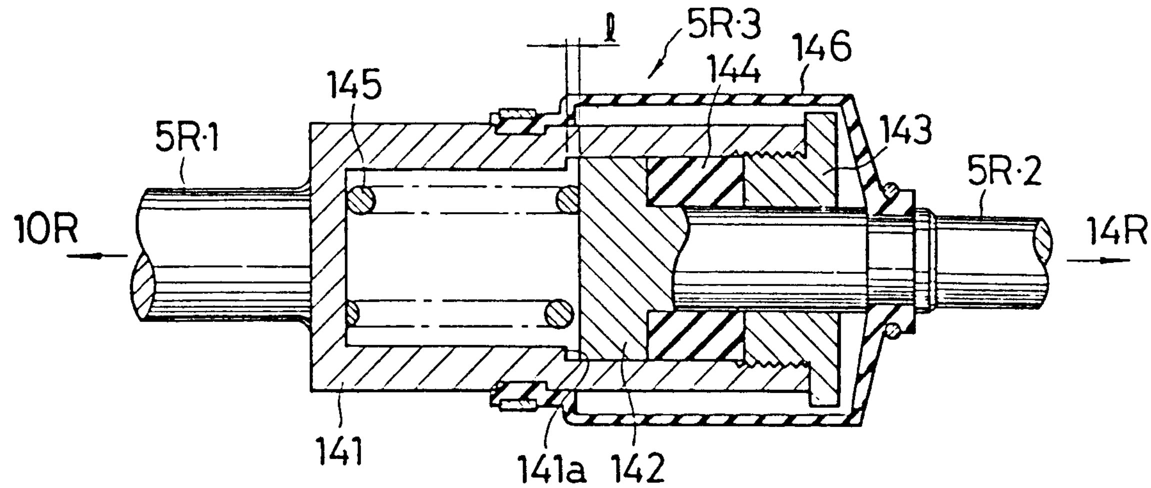
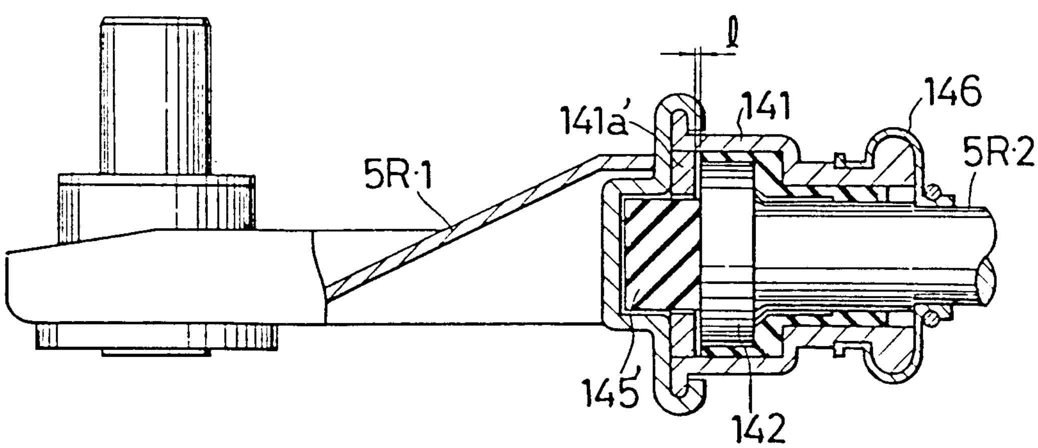

ℓ
5R·3
146
145
144
5R·1
143
5R·2
10R
14R
141
141a
142

FIG.27


ℓ
146
141a'
141
5R·2
5R·1
145
142